DAKOTA ACCESS, LLC

Energy Transfer Company

Dakota Access Pipeline Project

North Dakota Spill Model Discussion

WOOD GROUP MUSTANG

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1.0 PROJECT DESCRIPTION

The overall project is comprised of two separate but interconnected pipeline systems – the Dakota Access Pipeline (DAPL) and the Energy Transfer Crude Oil Pipeline (ETCOP). Together, DAPL and ETCOP form an approximately 1,167-mile long cross-country pipeline that will initially transport 450,000 barrels per day (BPD) of crude oil commencing at Stanley, North Dakota and ending at the Trunkline Pipeline tie-in located near Johnsonville, Illinois. Ultimately, the pipeline system will be capable of transporting 600,000 BPD of crude oil.

The DAPL system consists of approximately 148 miles of multi-diameter, crude oil supply pipelines in North Dakota and 1,019 miles of a 30-inch mainline that extends from the supply system in North Dakota to Patoka, Illinois. The supply system in North Dakota includes four pump stations. The 30-inch DAPL mainline has two pump stations - one each in South Dakota and Iowa.

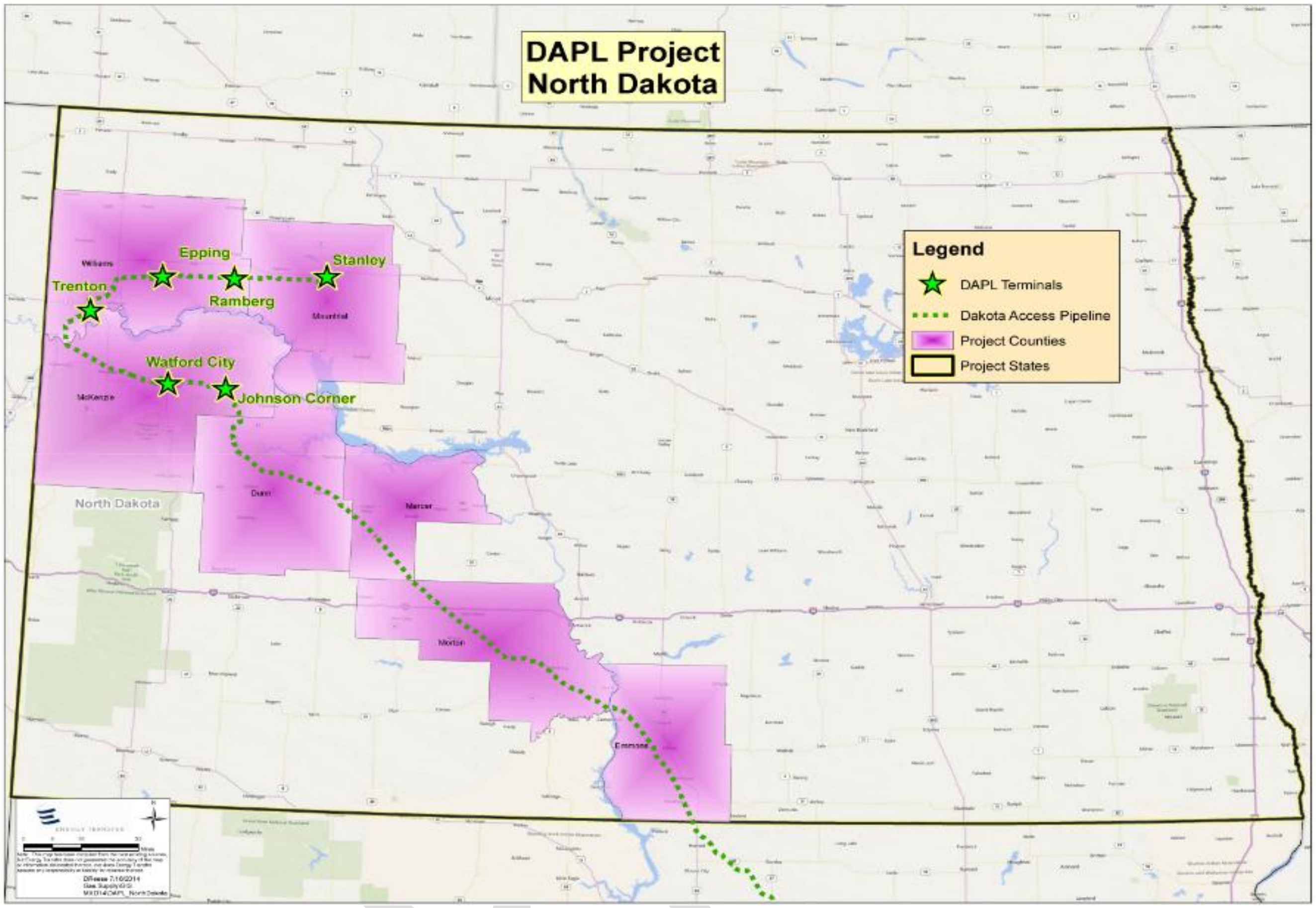
The ETCOP system consists of 32 miles of 30-inch pipeline that begins downstream of the DAPL terminus in Patoka, Illinois and connects to the existing 570-mile, 30-inch Johnsonville-Boyce Trunkline located near Johnsonville, Illinois. The ETCOP pipeline system includes a new pump station at Patoka, Illinois.

Both the DAPL and ETCOP systems will be provided with scraper traps for pigging operations, mainline valve and emergency flow restricting devices, and a Supervisory Control and Data Acquisition system (SCADA) to control operations of the pipelines.

This report specifically discusses results of a spill model analysis performed for the entire project as pertains to North Dakota.

Maps of the overall DAPL / ETCOP system and of the DAPL system as it traverses through North Dakota have been provided on the next two pages.

Overall Map of the DAPL / ETCOP System



2.0 SPILL MODEL – PURPOSE AND OVERVIEW

For the purposes of determining the relative consequences associated with a spill occurring along the DAPL pipeline system, a PHMSA–approved spill model was utilized.

This approach complies with 49 CFR Section 194.105 which requires a pipeline company to determine the relative impact of a worse-case release in each of its emergency response zones. This determination is based on the following factors:

- Maximum pump shutdown response time
- Longest duration for a mainline valve closure
- Maximum flowrate in the pipeline
- Largest opening in the pipeline (assumes a full-diameter pipeline separation)

The method by which the spill model determines the relative release volumes is outlined in the following pages.

3.0 SPILL MODEL - TECHNICAL COMPONENTS

The spill model is based on the "OILMAP Land" computer software. This software generates hypothetical spill points along a pipeline, calculates the crude oil volume discharged at each point, and then models the pathways of the spills based on topographical data and site conditions.

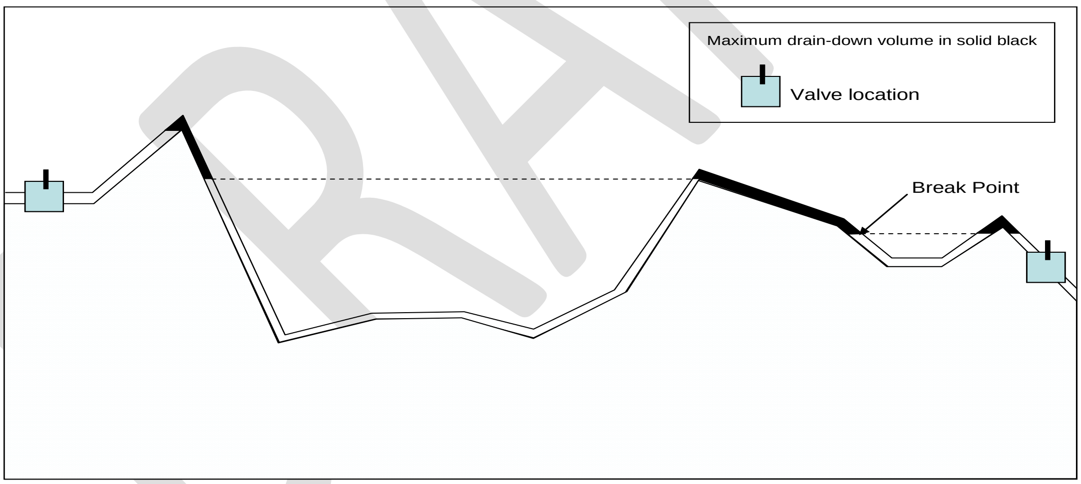
Volume Calculation

The spill model volumes are based on pipe diameter, flow rate, valve location, valve and pump shut down times, and the elevation profile along the pipeline.

When a pipeline break occurs, liquid flows from the pipeline until the line is shut down and the valves are closed. To determine the maximum release volume, the model assumes a full diameter break (guillotine) in the pipeline.

In the first phase of the calculation, liquid flows from the pipeline until the pumps are shut down.

In the second phase of the calculation, the pumps are no longer running, but some liquid may continue to flow downhill out of the pipeline due to the effects of gravity. This volume is restricted, however, to liquid contained in the pipeline segment between closed valves, as indicated in the following diagram:



In the above diagram, the only volume of liquid capable of draining from a non-pressurized pipeline segment between two closed valves is indicated in solid black.

Pathway Determination

Land based spills travel down slope over land due to the effects of gravity. In some cases, spills can approach a stream or other surface water feature.

Prediction of liquid flow over land and across water requires two unique modeling approaches as discussed on the following page.

- Liquid flow over land is governed by the characteristics and slope of the land surface. The land flow model takes into effect losses due to adhesion, the formation of small puddles, pooling in large depressions, and evaporation to the atmosphere.
- The water transport model moves oil on the water surface at a defined velocity and calculates oil lost to the shore from adhesion and oil evaporation to the atmosphere.

Effects of Adhesion

The amount of oil retained on the land surface as it flows down slope is determined by the nature of the land cover, e.g. dense vegetation is able to retain more oil than surface rock (ASCE 1969, Kouwen 2001, and Schwartz et al 2002).

Pooling on the land surface is the volume of oil retained within land depressions in the immediate area. The total oil lost to the ground is the sum of adhesion and pooling.

Effects of Evaporation

Oil evaporates as it spreads over land. The most volatile hydrocarbons (the light ends) evaporate rapidly - oftentimes in less than an hour (McAuliffe, 1989). The model uses a method called the Evaporative Exposure Model) of Stiver and Mackay (1984) which is used in most oil spill models to predict the evaporation rate.

In general, the rate of evaporation depends on surface area, composition of the crude oil, wind speed, and air and land temperature. The amount of oil evaporated is particularly sensitive to the surface area of the spreading oil and the time period over which evaporation is calculated.

The model software assumes evaporation ceases to occur once the total oil spill volume has been released. In reality, oil will continue to evaporate from the ground surface increasing the total evaporation amount. The model's conservative calculation of evaporative loss is consistent with a worst-case scenario approach.

4.0 MODEL INPUT PARAMETERS

The following data is reflected in the DAPL model:

Pipeline	Diameter (inches)	Flow Rate (bbl/hour)	Detection and Shutdown*
Stanley to Ramberg	12	4,833	12.9 minutes
Ramberg to Trenton	20	13,170	12.9 minutes
Trenton to Watford City	24	18,880	12.9 minutes
Watford City to Johnson’s Corner	30	18,880	12.9 minutes
Johnson's Corner - southward	30	25,000	12.9 minutes

* The mainline pumps are shutdown within 9 minutes, and the adjacent valves are closed within an additional 3.9 minutes.

The following crude oil properties are reflected in the DAPL model.

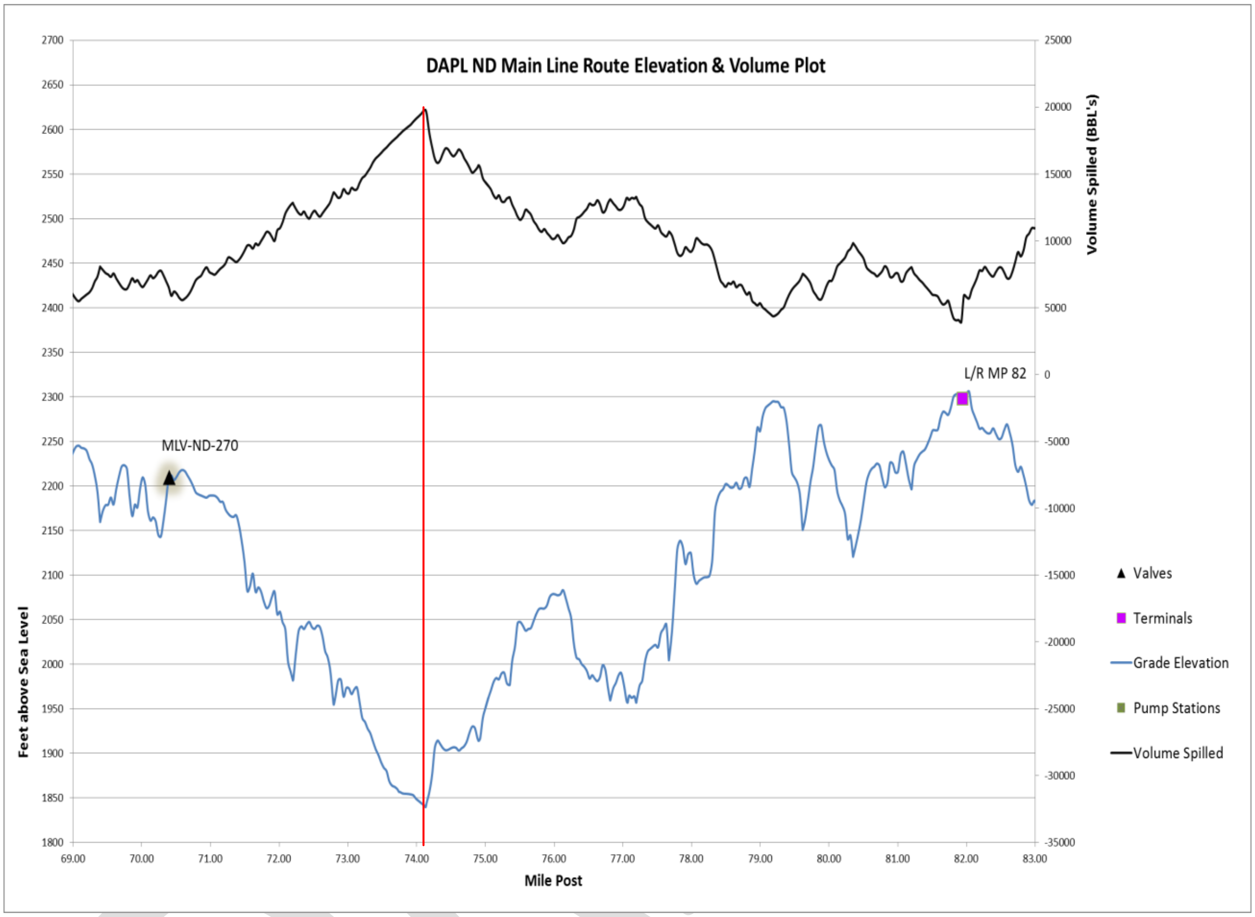
Property	Value
Density	50.2 lbs/ft^3
Temperature	64 °F
Boiling Point	331 °F
Gravity	41.8° API

The following operational parameters were used in the DAPL model.

Total Travel Time	6 hours	Time required for response equipment to arrive on site and for personnel to begin control and containment of the release.
Wind Speed	9 MPH	Constant wind speed used for evaporation calculation
Land Elevation	1,800' – 2,350'	10-meter resolution dataset provided by the United States Geological Survey (USGS)

DAPL Design Parameters	Value
Pipe Specifications	12-inch X-52 (0.375" WT) 20-inch X-70 (0.312" WT) 24-inch X-70 (0.375" WT) 30-inch X-70 (0.429" WT) 30-inch X-70 (0.625" WT)* * above ground, HDDs, road/rail/river crossings
Coating	Fusion bond epoxy (FBE) coating.
Maximum Operating Pressure	1,440 psi
Depth of Cover	4' minimum -exceeding federal requirements
Above ground versus buried pipe	All pipe shall be buried except at pump stations and valve sites.
Mainline Valve Operation	100% remotely controlled.
Pump Stations	6 pump stations in North Dakota

5.0 MODEL RESULTS



The largest calculated volume occurs at milepost 74.13 miles. Based on the ultimate pipeline flowrate of 600,000 BPD, the volume would be 19,809 barrels of oil. The volume would be reduced to 18,872 barrels based on the initial flow of 450,000 BPD through the pipeline.

DAPL's expectation is that the spill frequencies and volumes presented in this analysis are not likely to occur, but are provided as a conservative framework to ensure Agency decisions are based on knowledge of the potential effects, as well as allowing for DAPL to prepare for the worst-case scenario in its emergency response preparations as required by applicable federal regulations.

While this analysis reflects a maximum spill volume, actual incident data from the Hazardous Liquid Pipeline Risk Assessment (California State Fire Marshal 1993) indicates that spill volumes are significantly less than the maximum volume calculated by the model. For example, in 50% of actual incidents, the spill volume was less than 0.75% of what the model predicted. In 75% of actual incidents, the spill volume was less than 4.6% of what the model predicted.

Spill volumes are primarily controlled by mainline valve locations, the sensitivity of the DAPL leak detection and notification system, and the valve closure rates. These pipeline detection and control systems are incorporated into the DAPL project design, and represent the primary defenses for reducing spill volumes. Other procedures to reduce spill volume, by reducing drain down are discussed later. These procedures will significantly reduce the model's predicted maximum spill volume.

6.0 CLARIFICATION OF RESULTS

In the unlikely event of a spill, the actual size is expected to be significantly smaller than that maximum volume predicted in the model. This is due to the way the model calculates releases as described earlier. In particular:

Guillotine Break

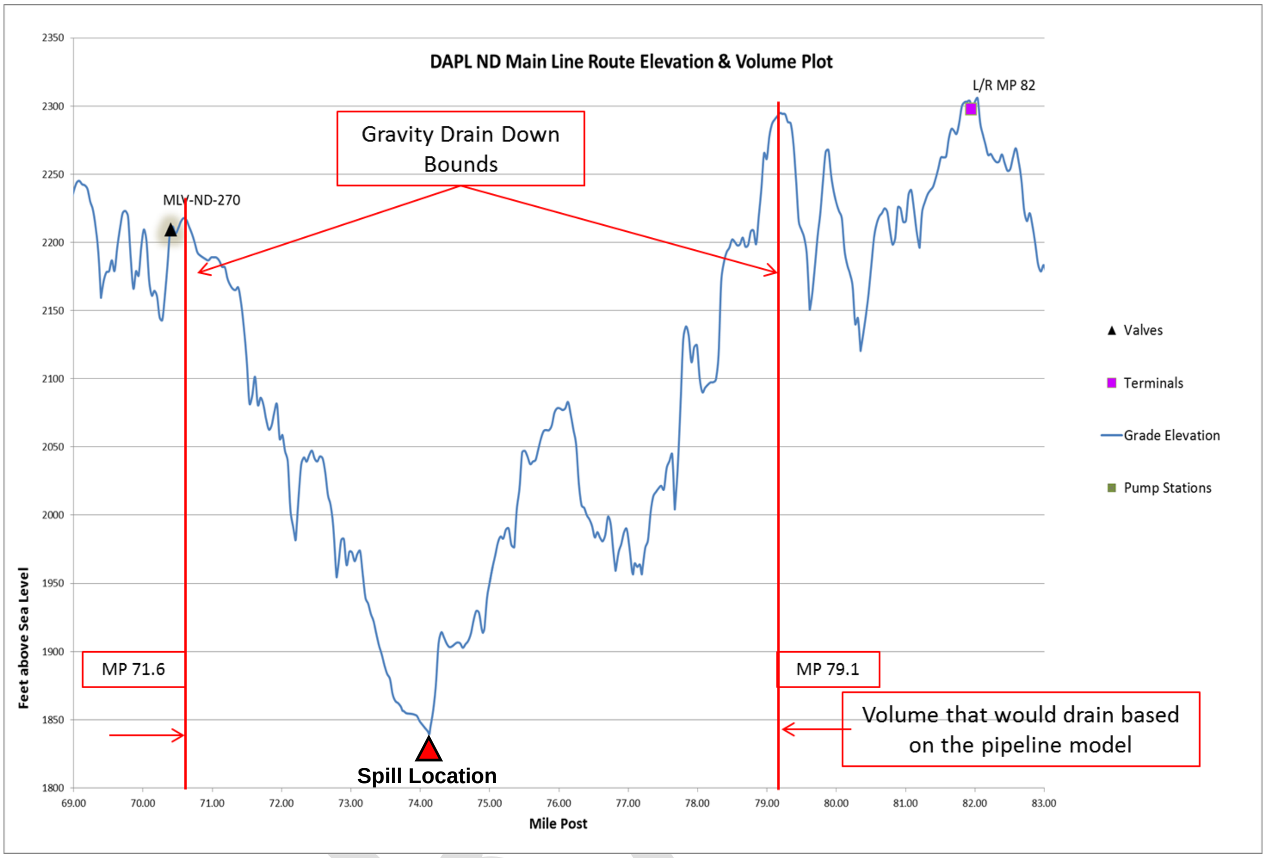
All PHMSA-approved spill models calculate the volume based on a full-diameter (guillotine) break on a pipeline. In reality, such full-diameter breaks are only likely to occur on small-diameter pipelines (< 16 inch). For larger diameter pipelines (> 20 inch) the most likely leak mechanism is due to punctures caused by augers or excavator bucket teeth.

Third-Party Contact

The most likely cause of damage to a pipeline is from contact during construction activities initiated by a third-party. In most cases this is due to the pipeline being struck by an auger or excavator. Specifically, the largest excavator built in the USA by Caterpillar can only generate 14,000 pounds of force at the end of the excavator bucket teeth. While this is enough force to create a small single-tooth puncture in a pipeline, it is not enough force to shear through the DAPL 30-inch diameter, 0.429-inch wall thickness pipeline, requiring 29,000 pounds of force.

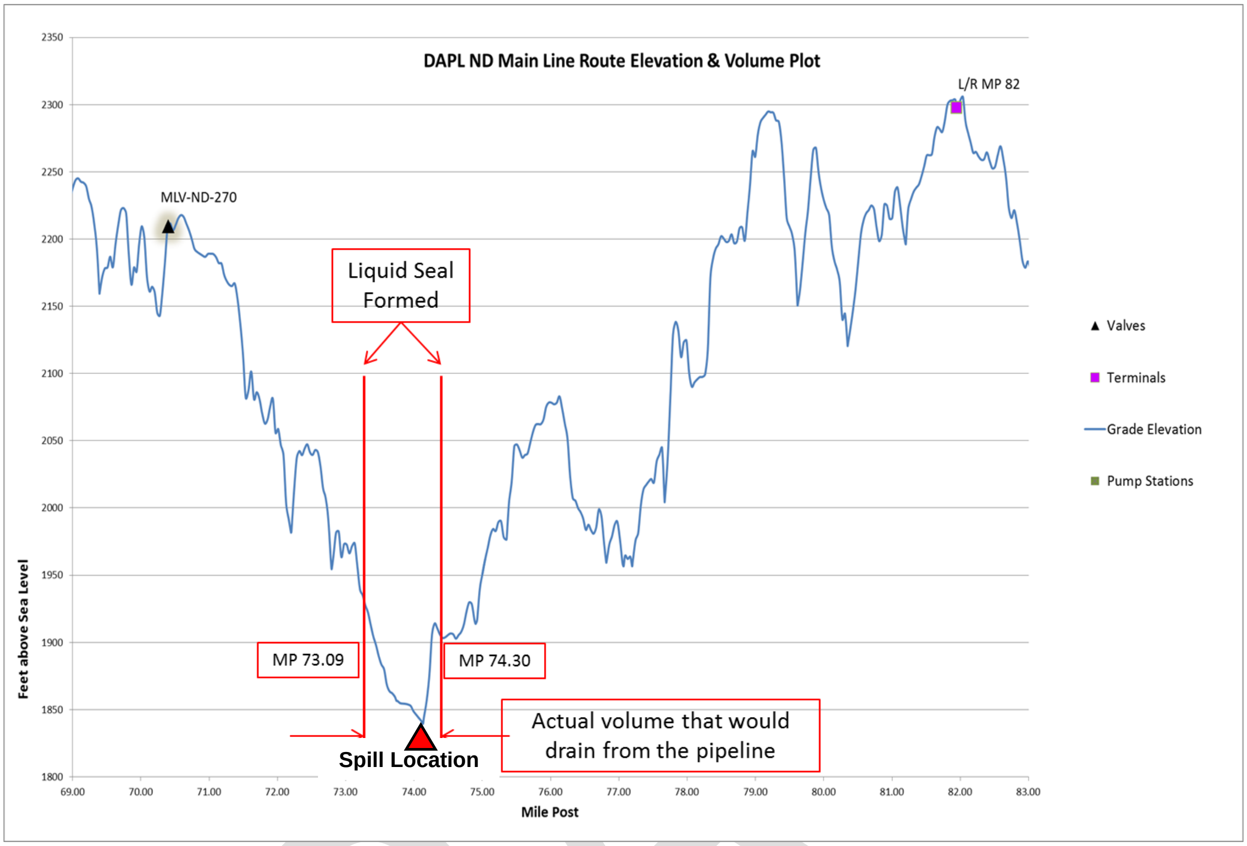
Anti-Siphon Effects

Though the pipeline model calculates volume based on the entire release of oil between valves, it does this by assuming air can enter the pipeline through the opening and evacuate that entire section of pipeline. In reality, air does not completely evacuate the pipeline, but rather, only enters the immediate area of the pipeline adjacent to the opening. Beyond this localized area, anti-siphon effects take over and minimize any further release of oil from the pipeline. This effect is illustrated in the graphs on the following two pages.



Worse-Case Scenario - Spill release based on the PHMSA model – Full-diameter opening with full pipeline drain down due to air purge.

The volume is 19,809 barrels based on the ultimate flow of 600,000 BPD through the pipeline. The volume is 18,872 barrels based on the initial flow of 450,000 BPD through the pipeline.



More Probable Spill Release – Full-diameter opening with reduced drain down due to anti-siphon effects. The length of the pipeline subjected to drain-down effects is reduced by 84%.

7.0 PIPELINE DESIGN AND OPERATING PARAMETERS TO REDUCE LEAKS

Major elements of the DAPL design and operational standards, which will greatly reduce the threat of a crude oil release:

- Pipe specifications that meet or exceed applicable regulations, with a quality assurance program for pipe manufacturers
- Use of the highest quality external pipe coatings (fusion bond epoxy or FBE) to prevent corrosion.
- Active Cathodic Protection applied to the pipeline and facilities
- Four feet of soil cover will be provided over the buried pipeline in most locations which exceeds federal standards.
- A variety of pipeline system inspection and testing programs will be implemented prior to operation to prevent leaks.
- Non-destructive testing of 100 percent of girth welds

- Hydrostatic testing of the pipeline to 125% percent of the Maximum Operating Pressure (MOP).
- A continuous pipeline monitoring system (Supervisory Control and Data Acquisition [SCADA]) that remotely measures changes in pressure and volume on a continual basis. This measurement data is immediately analyzed to determine potential product releases anywhere on the pipeline system.
- Meter comparison system that continuously verifies meter flows match at multiple points along the pipeline in real-time.
- Periodic pipeline integrity inspection programs using internal inspection tools to detect pipeline diameter anomalies indicating excavation damage, and loss of wall thickness from corrosion.
- Periodic above-ground Close Interval Surveys (CIS) conducted along the pipeline.
- Aerial and ground surveillance inspections. The aerial inspections will be conducted 26 times per year (not to exceed 3 weeks apart) to detect leaks and spills as early as possible, and to identify potential third-party activities that could damage the pipeline.
- Mainline valves are installed along the pipeline route to reduce or avoid spill effects to PHMSA-defined HCAs.
- In the unlikely event of a spill, the implementation of these measures, along with the leak detection program, will significantly reduce both the likelihood and impact of such an incident.
- Implementation of a Public Awareness program
- Participation in "One-Call" and "Before You Dig" notification systems.